



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

A STABLE SINGLE BUFFER SOLUTION

P_H 1 TO P_H 12

S. F. ACREE; R. R. MELLON;

PAULINE M. AVERY, AND E. A. SLAGLE

From the Hahnemann Hospital, Rochester, N. Y.

It has already been pointed out by one of us (Acree)¹ that there are obvious advantages to be derived from the use of buffer mixtures covering a wide P_H range, especially if they can be stabilized and so selected as to form a practically continuous, as well as smooth, curve. We know of no single solution that has been recommended so far that embraces these requisites.

Accordingly, we have constructed such a mixture, having components whose dissociation constants are so graded that when the titration curve of one ends the next begins (chart 1). In point of fact, the curves overlap somewhat, involving a condition that will be discussed in detail (chart 2).

The components, as employed in the buffer solution, are: (1) 1 molecule of KH_2PO_4 , with a K_a of 1.1×10^{-2} ; (2) $\frac{5}{8}$ mol. of sodium formate with a K_a of 2×10^{-4} ; (3) $\frac{3}{8}$ mol. of sodium acetate with a K_a of 2×10^{-5} ; (4) the second group of K_2HPO_4 with a K_a of 2×10^{-7} ; (5) 1 mol. of sodium phenol sulphonate with a K_a of approximately 10^{-10} ; (6) M/200 thymol to saturation (for H_2O , 0.08) with an approximate K_a of 0.5×10^{-10} ; (7) the third group of H_3PO_4 with a K_a of 10^{-12} .

The ionization constants of sodium phenol sulphonate and thymol have not been measured as yet with the hydrogen electrode, so we are not in possession of all the separate titration curves for the various components. This phase of the subject will be completed shortly, and is not essential for this presentation, as the curve as shown has been developed with the hydrogen electrode and repeatedly checked, both electrometrically and colorimetrically. Points throughout the entire length of the curve were made at intervals of M/8 of alkali or acid, which corresponds to about 0.3 P_H .

Thymol, used for its well-known antiseptic properties, will probably take the sixth position in the series, based on its close relation chemically

Received for publication Feb. 1, 1921.

¹ Jour. Bacteriol., 1920, 5, p. 491.

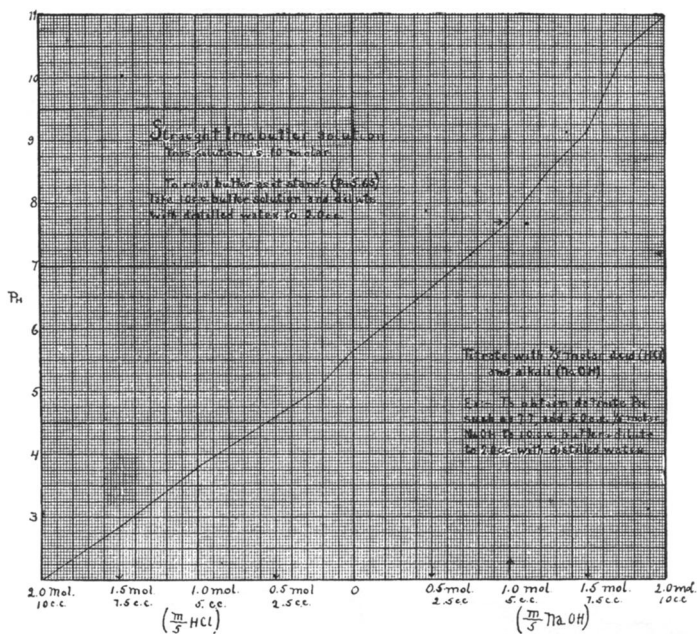


Chart 1.—Straight line buffer solution.

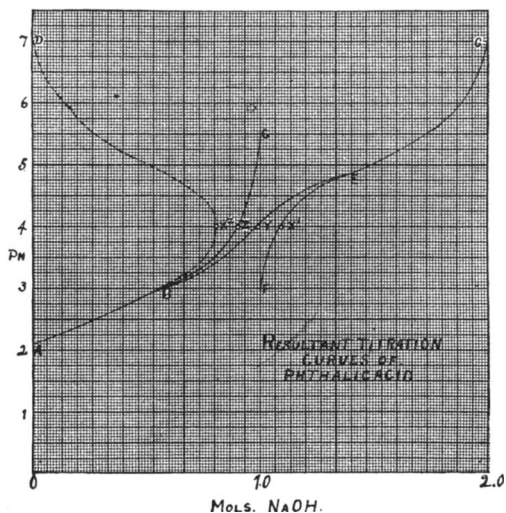


Chart 2.—Resultant titration curves of phthalic acid.

to phenol, whose K_a is known. The solution was developed to fill a practical need; and, by analogy with work done on the resultant curves of other polybasic acids, we have reason to feel confidence in its straight line feature.

In this connection we wish to refer to our study of phthalic acid, a dibasic acid (chart 2). Curves ABC and FEG represent, respectively, titration curves for Na acid phthalate and disodium phthalate if they could be plotted separately, i. e., as representing the complete neutralization of one H before the other has been attacked. Overlapping, however, occurs, eventuating in the resultant curve BYE. Its position has been determined by calculations developed from formulae in papers now in press. The hydrogen electrode has confirmed experimentally the accuracy of the formulation. It is of interest, however, that its position can be located graphically, as shown in chart 2, in the following manner:

Any point of P_H on FEG is selected, and a measure of the alkali taken from this point back to the ordinate from which the curve starts, as in X^1 on FEG to ordinate at 1. The identical distance is measured from a similar point (one having the same P_H on the curve ABC forward, and the resulting point will be a point on the resultant curve BE. Assume it is at Y. When this same distance is measured backward horizontally from curve ABC, the curve ABD is developed. From the point X^2 on ABD, forward to Z on ABC represents the amount of the mono-acid salt that has been transformed to disodium salt, and twice this amount (X^2Z), that is, X^2Y is the molar concentration of alkali required to form the corresponding concentration of dibasic salt X^2Z . It therefore follows that the abscissa values ² OX^2 plus X^2Y give the total molar concentration of alkali which has been added to give these amounts of mono- and dibasic salts and the resulting P_H values, or C_H . By finding a number of such points Y for P_H values, we can easily plot the resultant curve ABYEG, giving the relation between the P_H value and the molar equivalents of alkali added to the phthalic acid.

1. ABC, total curve for sodium acid phthalate formed
2. ABX^2 , curve for NaH salt at any moment
3. ABYEG, resultant curve
4. Z^1 , free phthalic acid

² For convenience we have indicated the vertical ordinate by 0 and the ordinate corresponding to one mol. of alkali by 1.

5. $1X^1$, disodium phthalate
6. ZX^2 , transformed mono-acid salt

The distance from point X on ABD back to line O, starting point of curve ABC, represents the amount of untransformed mono-sodium salt—Na acid phthalate in this case. Z1 is the amount of free phthalic acid still unneutralized. From this curve we can quantitate the various components of the reaction products found when a dibasic acid is neutralized by alkali. Not only can the individual titration curves be compounded into a resultant curve, but it seems probable that this in turn can be analyzed back into the separate titration curves for each acid or basic group present in unit or fractional equivalents. It may be possible, therefore, to identify quantitatively bases and acids generated in culture mediums of known composition.

Returning to the curve for the single buffer solution: To obtain any desired P_H it is only necessary to locate the point on the curve that is intercepted by the desired P_H value, and read off the amount of M/5 HCl or NaOH necessary to produce this P_H . For example, to obtain a P_H of 7.7, add 5 c c of M/5 NaOH to 10 c c buffer and dilute to 20 c c with distilled H_2O . The indicator covering this range is then added.

For convenience we are testing out the feasibility of adding one or two indicator tablets, which are nothing more than sugar of milk, compressed in tablet form and impregnated with a definite quantity of the dye. In the same way, it is often convenient to add tablets of buffers to mediums and biologic fluids. Such measures will receive more detailed treatment at a subsequent time.